Capability of Fitness Testing to Predict Injury Risk During Initial Tactical Training: A Systematic Review and Meta-Analysis

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The capability of fitness testing to predict injury risk during initial tactical training: A systematic review and meta-analysis

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Background

- Tactical personnel can be defined as those individuals whose sworn duty it is to protect their country and/or community, and who may place themselves at risk for this purpose [1]
- All tactical personnel require sufficient physical fitness to be able to complete daily occupational tasks safely and effectively [2]
- In order to ensure operational capability under varied and often extreme demands, many tactical organizations have put physical fitness standards in place for initial entry trainees [3]
- The required training, amongst other factors, to meet these standards can place individuals at risk of injury [4,5]
- Therefore, this review sought to identify studies that have investigated associations between fitness measures and injuries, and to synthesize and report key findings to inform tactical organizations

Methods

- A comprehensive literature search within four databases (PubMed, Embase, CINAHL, SPORTDiscus) was performed (Figure 1)
- The Defense Technical Information Center (DTIC) was also searched
- After duplicates were removed, the remaining articles were screened for the following inclusion criteria:
  a) Evaluated one or more measures of fitness
  b) Study included data on training injuries and risk of injury
  c) Study was observational (e.g., not reporting on an intervention)
  d) Was peer-reviewed, original research, and
  e) Published after 1997

  Articles were excluded under the following criteria (Figure 1):
  a) No fitness measure correlated with injury risk during initial tactical training
  b) Single event follow-up
  c) Sporting injury, or
  d) Heat injury
- Articles were critically appraised to determine the methodological quality by two authors (CT & SS) using the CASP toolkit [6]
- Cohen's kappa coefficient was used to measure the level of agreement and was calculated by a third author (RO)
- Studies were selected for meta-analysis based on the following criteria:
  - Study investigated a timed running event and injury risk
  - Data were reported categorically with a referent risk ratio
- A random-effects model was used to account for differences in tactical subpopulations, different run lengths and varied sample sizes (Figure 2)
- To account for differences in categorization (quartile, quintile, half), only the fastest and slowest group from each study were included

Results

Figure 1: Literature Search and Screening Method

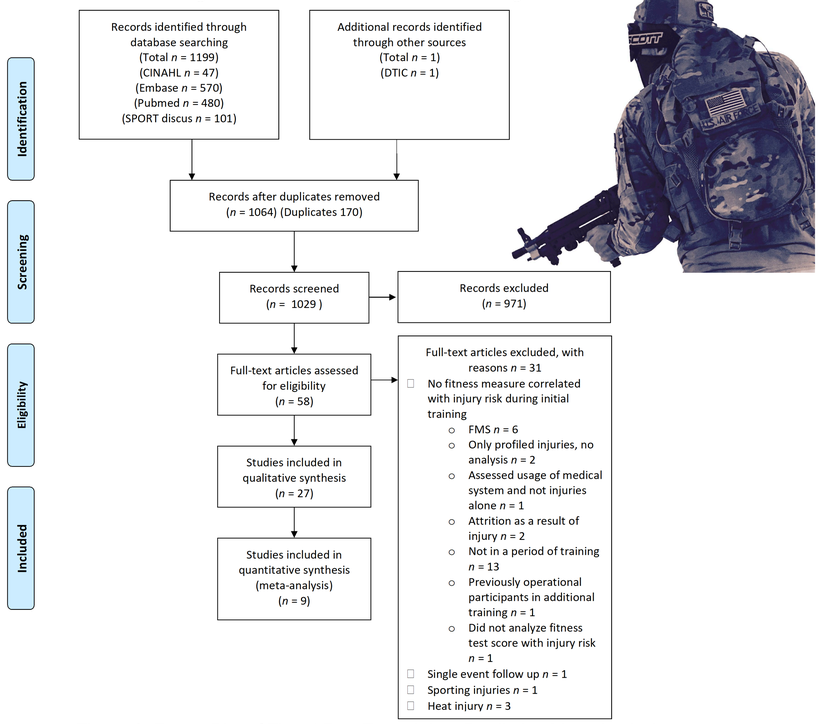
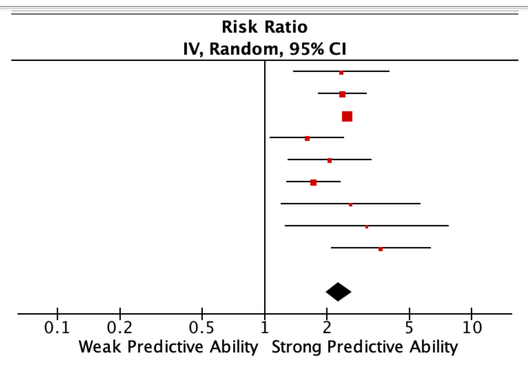


Figure 2: Forest Plot of Timed Run Event Injury Prediction Meta-Analysis

Study or Subgroup	log[Risk Ratio]	SE	Lowest Performers Total	Highest Performers Total	Weight	Risk Ratio IV, Random, 95% CI
Blacker 2008	0.8502	0.2697	2688	2664	6.3%	2.34 [1.38, 3.97]
Hall 2017	0.8629	0.1347	610	302	16.3%	2.37 [1.82, 3.09]
Jones 2017	0.9163	0.0208	28393	28713	34.1%	2.50 [2.40, 2.60]
Knapik 2001	0.47	0.2069	169	161	9.5%	1.60 [1.07, 2.40]
Knapik 2011	0.7227	0.2349	106	108	7.8%	2.06 [1.30, 3.26]
Lisman 2013	0.5423	0.1505	430	428	14.4%	1.72 [1.28, 2.31]
Rauh 2006	0.9555	0.3945	204	204	3.2%	2.60 [1.20, 5.63]
Shaffer 1999	1.1346	0.4599	272	267	2.4%	3.11 [1.26, 7.66]
Shaffer 2006	1.2892	0.2792	696	686	5.9%	3.63 [2.10, 6.27]
Total (95% CI)			**33568**	**33533**	**100.0%**	**2.27 [1.96, 2.63]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 13.42$, df = 8 (P = 0.10); $I^2 = 40\%$
Test for overall effect: Z = 11.01 (P < 0.00001)



Results

- Mean CASP score was 10.6/12 (range 9-12)
  - Level of agreement: $k = 0.750$
- Three tactical subpopulations were represented:
  - Military, Police, and US Federal Bureau of Investigation
- Studies by sex: n=11 included both male and female trainees, n=8 males only; n=5 females only
- Studies by fitness measure: n=21 investigated a measure of aerobic fitness, n=9 investigated a pushup test, n=10 investigated a situp test, n=3 investigated a chinup or pullup test, n=3 investigated a true strength measure
- Studies by injuries: n= 11 reported on any musculoskeletal injury, n=7 examined lower limb stress fractures specifically, n= 2 reported on any injury, n=2 reported any musculoskeletal injury requiring hospitalization, n=2 reported any musculoskeletal injury requiring referral, n=1 examined time-loss injuries, n=1 reported any lower limb injury

Summary

- Meta-analysis indicates that slower run times are unequivocally associated with a substantially higher risk of injury during training: RR 2.27 (CI=1.96-2.63)
- Direct physiological testing of VO_{2max} as performed by Knapik et. al., [7] agrees with the meta-analysis results indicating metabolic fitness is key in mitigating injury risk during tactical training
- True strength tests described significant findings, but only three publications investigated a true strength measure
- Potential differences in findings may be due training environmental specificity where those training environments which perform a high amount of running may find running as a predictor as opposed to those training environments who perform less running.
- Based on the data from this review, tactical organizations may benefit from using fitness testing data to identify personnel in need of intervention to minimize risk of training injury

Conclusion

- Individuals who perform poorly on a timed run, in particular, are at greater risk of injury than fitter peers when undergoing tactical training
- Fitness test results could be used as a reliable means of identifying trainees at greater risk of injury for proactive intervention but further research specific to the training environment is needed

Key References

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